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ABSTRACT

The effects of age, sex, and curriculum upon the cognitive performance of 20 college students and 20 college-educated elderly individuals were examined. Young adult participants (M=20.55) and elderly participants (M=67.85) were given a battery of formal operational tasks, a measure of field independence/field dependence, a short-term memory measure, and a measure of tolerance of ambiguity. Results of analyses of variance and covariance indicated a lack of significant age differences on any of the measures of formal reasoning. However, gender and curriculum were significant predictors of cognitive performance for both cohort groups. These results suggest that within the sample, formal operational thought abilities are present. Perhaps the present study will call additional attention to the impact of life experience (i.e., curriculum specialization and lifelong learning), years of education, and gender on the development of formal operational thought in the adult and aging years. (Author/PN)

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The Influence of Personality, Curriculum, and Memory Correlates on Formal Reasoning in Young Adults and Elderly Persons[1]

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Running Head: Formal Reasoning in Adults and Elderly Persons

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Abstract

The study examined the effects of age, sex, and curriculum upon the cognitive performance of twenty college students and twenty college educated elderly individuals. Young adult participants (M = 20.55, SD = 8.2) and elderly participants (M = 67.85, SD = 3.37) were given a battery of formal operational tasks, a measure of field independence/field dependence, a short-term memory measure, and a measure of tolerance of ambiguity. Results of a series of 2 x 2 x 2 analyses of variance and covariance resulted in a lack of significant age differences on any of the measures of formal reasoning. However, gender and curriculum were significant predictors of cognitive performance for both cohort groups. These results suggest that within the sample formal operational thought abilities are present.

Key words: Adult Development, Aging, Cognition, Piagetian Theory

One major type of research stemming from Piagetian theory is the assessment of formal operativity as a measure of intellectual functioning in old age. Much of this research suggests an apparent decline of Piagetian infralogical and logical abilities in elderly individuals. The reasons for the meaning of the decline have by no means been resolved (Flavell, 1970; Hooper et al., 1971; Horn, 1970).

However, recently researchers have begun to give serious attention to possible enviornmental, educational, and organic factors which may affect cognitive functioning. These research findings have pointed to the influence of educational level, formal instruction, and occupational affiliation on cognitive functioning (Denny and Cornelius, 1975; Labouvie-Vief and Chandler, 1978; Labouvie-Vief, 1980; Papalia, 1972). These studies lead to a question of the importance of another, albeit confounded, component of educational experience: curriculum.

Furthermore, previous Piagetian research has noted the parallel development of memory strategies and the solution of Piagetian formal operational tasks (Case, 1978; Hooper, Swinton, and Sipple, 1979; Kail and Hagen, 1976; Niemark, 1979; Pascual-Leone, 1970), the high correlation of successful formal operational task performance and a high degree of field independence (Case, 1978, Niemark, 1979; Pascual-Leone, 1970), and the relationship between the ability to resist premature closure or a high level of ambiguity tolerance and successful

formal operational task performance (Lunzer, 1978).

Despite empirical attempts to quantify the relationships of these variables to performance on formal operational tasks, few conclusions have been reached concerning the saliency of these variables to performance on formal operational tasks.

The experiment reported here was conducted in an attempt to systematically explore specific educational, personality, and memory factors which may interfere with or enhance formal operational thought in young adults and elderly persons.

Method

Participants.--The sample consisted of ten males and ten females in each of the two age groups (19-24 years; 63-75 years). A power coefficient of .90 was calculated for a sample of this size. All participants had completed at least three years of a college education. In addition, all participants were currently enrolled at the University of Wisconsin-Madison and all reported being in good physical health and having good vision. All were paid a small honorarium.

Procedure.--Participants were individually administered the Witkin Embedded Figures Task, Revised Version of the Ambiguity Tolerance Scale, the Tomlinson-Keasey and Campbell Test of Formal Reasoning, Lunzer Test of Formal Reasoning, a Syllogistic Reasoning Task, and Memory Span for Digits: Forward and Backward.

The presentation order of the tasks was counterbalanced across the three content areas of personality measures,

formal reasoning, and memory tests for all of the participants.

Instruments

The Witkin Embedded Figures Task (Witkin, Dyk, Faterson, Goodenough, and Karp, 1962) The Embedded Figures Task consists of twenty-four complex geometrical figures, some in black and white and some in color presented to the participants on separate cards. Each complex figures contains one of eight simple figures. In administering the test, a card on which a complex figure appears is shown to the participant for fifteen seconds, and the participant is asked to describe it. Then a card containing the simple figure is shown to the participant for ten seconds. Following this, the complex figure is again presented and the participant's task is to find the simple figure and to trace it with a blunt stylus. The score on each item is the time taken to find the embedded figure. A maximum of three minutes per card is allowed, after which a failure is recorded and the next card is presented.

Tolerance for Ambiguity

Tolerance for ambiguity was measured by the Revised Version of the Ambiguity Tolerance Scale (MacDonald, 1970). The test consists of twenty true and false questions. A total score of 20 is possible. The internal consistency estimate for the twenty-item scale was computed using the more conservative estimate provided by the Kuder-Richardson Formula

20. The Kuder-Richardson Formula 20 yielded a correlation of .73.

Tomlinson-Keasey and Campbell Formal Reasoning Test

The Tomlinson-Keasey and Campbell (1977) was devised as a measure of formal operational thought. This test yields scores on the participants' ability to perform the following kinds of formal operations: proportionality, systematic search, isolation of variables, word analogies, abstraction, correlation and probability. Only three of the most valid and reliable subtests, proportionality, systematic search, and isolation of variables, were administered to the participants.

The version of proportionality used in the present test is based on recipe conversions and hence should be conceived of as a kind of problem encountered on a day to day basis.

The systematic search task was adopted from Inhelder and Piaget (1958). This task requires the participants to separate variables and give explanations for the necessity of isolating variables. The participants are told that they are working on a probelm involving flexibility of rods and they must try to figure out which is more flexible, long or short.

The Lunzer Test of Formal Reasoning

The Lunzer Test of Formal Reasoning (1965) was utilized to assess another domain of formal operational thought. This test consists of twenty word analogies and twenty mathematical problems. Internal reliability of this measure equals .93.

Syllogistic Reasoning Task

The Syllogistic Reasoning Task (Sipple, 1978) measures the participant's understanding of logic. This test consists of four concrete syllogisms. The participant's task to determine the truth or falsity of twelve separate statements based on four logical premises.

Memory Span for Digits: Forward and Backward

Memory Span for Digits: Forward and Backward (Wechsler, 1974) was utilized to measure the participant's ability to repeat a series of digits forward and backward.

Results and Discussion

Analysis of covariance was computed to determine possible differences between the two age groups. Analysis of covariance with educational level, Witkin Embedded Figures Task, or Memory Span for Digits Test as covariates was utilized when the cognitive measures indicated significant effects due to one of these covariates. These covariates were selected based on previous research which indicates a relationship of these variables to age. When the result was a lack of significant covariates, subsequent analyses were conducted utilizing a 2 x 2 x 2 analysis of variance procedure. Table 1 and 2 contain a summary of all the results.

There were significant age differences on the measures of field-independence and field-dependence and memory span for digits. The young adults were significantly more field-independent and demonstrated a greater short term or recent

memory span. The result of greater field-independence among the young adult sample is consistent with the literature. However, greater short-term memory span for young adults, while inconsistent with the literature, was probably due to the use of the backward digit span task.

Furthermore, significant effects were observed for gender on the Number Series Subtest of the Lunzer Test of Formal Reasoning, $F(1,39) = 17.25$, $p < .01$, $w^2 = .28$, the Total Lunzer Test of Formal Reasoning, $F(1,39) = 8.44$, $p < .01$, $w^2 = .17$, and the Total Tomlinson-Keasey and Campbell Test of Formal Reasoning, $F(1,39) = 4.33$, $p < .05$, $w^2 = .08$. On each of these tasks, males performed significantly better than females.

Significant effects were also observed for curriculum on the Number Series Subtest of the Lunzer Test of Formal Reasoning, $F(1,39) = 5.14$, $p < .05$, $w^2 = .08$, and the Total Tomlinson-Keasey and Campbell Test of Formal Reasoning, $F(1,39) = 4.15$, $p < .05$, $w^2 = .08$. In both instances, the natural and physical sciences majors performed better than the social science and humanities majors.

Finally, a significant effect of age was observed on the personality measure of Tolerance of Ambiguity, $F(1,39) = 25.21$, $p < .01$, $w^2 = .35$. Interestingly, the elderly demonstrated a higher tolerance of ambiguity than the young adults.

All subsequent analyses indicated no further significant main effects or interactions due to age, gender and/or curriculum. However, while both cohort groups performed at

the formal operational level, as indexed by their scores on the Lunzer Test of Formal Reasoning and on the Tomlinson-Keasey and Campbell Test of Formal Reasoning, neither group performed much better than chance on the Syllogistic Reasoning Task. This finding is consistent with previous research in this area which indicates error rates are high at all age levels among otherwise highly intelligent adults (Karplus and Karplus, 1970; Lunzer, 1978).

In conclusion, the results of the present investigation indicate that among this highly educated group of young adults and elderly individuals, logical abilities as measured by a variety of formal tasks, are operationally intact This general finding of formal operativity is in contrast to the results that are frequently reported in the literature for both young adults and elderly individuals. One explanation is that this entire sample represented a highly motivated and educationally elite group. One must be cautious in generalizing the present findings to groups of people who are less well educated, less motivated, and not currently enrolled in an educational setting.

Hopefully, the present study will call additional attention to the impact of life experience (i.e. curriculum specialization and lifelong learning), years of education, and gender on the development of formal operational thought in the adult and aging years. As educational levels and opportunities for lifelong learning increase for future cohorts, these types of results could conceivably appear more frequently.

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Table 1. Covariate-adjusted means for Young and Old Males and Females, and Natural/Physical Science and Social Science/Humanities (Covariates listed in parenthesis)

Test	Young	Old	Male	Female	Natural/ Physical Science	Social Science/ Humanities
Tolerance of Ambiguity (Embedded Figures)	9.09	13.96**	11.12	11.93	11.90	11.15
Lunzer: Number Series (Educational Level)	6.85	7.52	8.57	5.53**	7.90	6.20*
Lunzer: Total Score (Educational Level)	29.74	32.11	33.99	27.86**	32.68	29.17
Tomlinson-Keasey and Campbell: Systematic Search (Digit Span)	11.97	11.43	12.32	11.08	12.51	10.89
Tomlinson-Keasey and Campbell: Total Score (Digit Span)	26.70	26.90	28.22	25.38*	28.10	25.50*

*Significant at $p < .05$

**Significant at $p < .01$

Deviations for Young and Old Participants

Test	Young		Old	
	Mean	SD	Mean	SD
Tolerance for Ambiguity	10.10	2.80	12.95	2.15
Syllogism	7.60	1.66	7.06	1.64
LUNZER (Word Analogies)	16.60	2.15	14.60	4.49
LUNZER (Number Relations)	7.95	2.02	8.60	2.00
LUNZER (Number Series)	7.35	1.72	6.75	2.48
LUNZER (Total Score)	31.90	4.82	29.95	8.03
Tomlinson-Keasey and Campbell (Metric Recipe)	4.20	1.18	4.50	.79
Tomlinson-Keasey and Campbell (Systematic Search)	12.95	2.41	10.45	3.78
Tomlinson-Keasey and Campbell (Isolation of Variables)	10.85	1.20	10.60	1.25
Tomlinson-Keasey and Campbell (Total Score)	28.00	3.65	25.60	4.64